INTELLIGENCE

Introduction

The study of intelligence is one of psychology's most interesting and controversial subjects. Psychologists have conducted innumerable studies on the nature of intelligence and have developed many programs aimed at improving intellectual performance. Psychologists also pioneered the development of intelligence tests. Since the early 1900s, when the first effective intelligence test was developed, psychology has laid claim to the empirical study of intelligence. In fact, the measurement of intelligence is one of the most publicly visible functions that psychologists perform.

Yet, there is a strong irony in all of this. Despite the major effort invested in the measurement of intelligence, no area of psychology remains more controversial. In the past 50 years, intelligence test have encountered a host of critics questioning whether the tests provide an accurate measure of intelligence, whether they are biased toward the knowledge and values of particular segments of society, and whether they play any useful role in selecting people for particular vocations.

The controversy surrounding intelligence tests has been debated within the academic community for many years but on occasion has become part of the public consciousness in dramatic fashion. Recent illustrations include a wrenching court case involving a class action suit field on behalf of defendants who felt that intelligence tests unfairly assigned them to special education classes for the mentally retarded, lively debates about the value of college entrance exams (a form intelligence testing) in predicting success in college, and continuing discussions of the meaning and consequences of studies showing genetic influences of intelligence.

Each of these issues has important implications for the scientific study of intelligence. As psychologists confront these modern-day controversies, they are forced to consider carefully some very basic questions: How is intelligence defined and measured? What factors affect performance on an intelligence test? Do intelligence test fairly assess the intellectual abilities of people from all walks of life? These are the same questions that confront us as we explore the development and construction of the modern intelligence test.

The Nature of Intelligence

Although intelligence tests have existed for over 75 years, disagreement about the nature of intelligence persists. Why is this so? One possibility is that because people behave intelligently in so many different situations, it is difficult to find an all-encompassing definition. Satisfactory performance is school, for example, may be one expression of intelligence, while diagnosing why a car won't start may be another. This diversity in intelligent behavior is complicated even further when we consider what different societies values as intelligent. In North America, people tend to think of intelligence primarily as verbal fluency. But in certain African societies, intelligence means expert hunting, while Pacific islanders think to intelligence as the ability to navigate the seas skillfully. Clearly, people value many different behaviors as intelligent.
Confronted with such diversity in the nature of intelligent behavior, it is small wonder that psychologists have often failed to agree on a comprehensive definition. Years ago, the editors of the Journal of Educational Psychology invited 17 leading scholars to express their opinions on the nature of intelligence. While they achieved some agreement, nearly 17 different definitions of intelligence emerged from this symposium. Although modern psychologists know much more about mental abilities, the difficulty is far from resolved.

One possible solution is to create a broad definition that addresses the complexity of the word intelligence. David Wechsler is one psychologist who has attempted such a definition. Wechsler is a well-known student of intelligence who has developed several widely used intelligence tests. He believes that intelligence is the capacity to understand the world and the resourcefulness to cope with its challenges. Wechsler has also suggested that intelligence is the capacity to act purposefully, to think rationally, and to deal effectively with the environment. By these broad standards, people act intelligently when they learn from past experience, seek effective solutions to everyday problems, and adapt to the world around them.

We can accept Wechsler's definitions of intelligence, as many psychologists do, but difficulties persist. A major problem is the issue of value judgments we referred to earlier. Although Wechsler uses broad terms – coping, resourcefulness, and rationality – they nonetheless imply particular values. For example, many places in the world do not share the North American emphasis on the role of verbal abilities in thinking and problem

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solving. Furthermore, even within this culture, different circumstances demand different types of coping and resourcefulness. Certainly, what is required to the ambitious college student is different from what is demanded of the ghetto child living in impoverished conditions. This is why the word intelligence always represents, in part, a value judgment. To call someone intelligent is to say that the individual possess qualities that you believe are adaptive and resourceful.

Finally, we must acknowledge the distinction between intelligence and performance. People who posses good problem-solving skills, and are thus typically regarded as highly intelligent, do not always regarded as highly intelligent, do not always perform efficiently in everyday tasks. Few of us would question, for example, the insight and wisdom of Thomas Edison whose discoveries about the transmission of electricity changed the way we live. Yet Edison fared rather poorly in an area often thought to be closely related to intelligence – classroom performance.

With this overview in mind, we turn to the question of how intelligence is operationalized or measured. Since the turn of the century, psychologists have relied on one instrument to measure intelligence – the famous (and sometimes infamous) intelligence test. Like any test, it is influenced by the assumption and biases of the test constructions. As you read about the development of intelligence tests, you should be aware of how prevailing view about the nature of intelligence affected the kinds of tests that psychologists constructed.

Theories and models of intelligence:

The Structure of the Intellect

So far we have focused on two rather practical topics: how intelligence tests are constructed and how people perform on these tests. We turn our attention now to a more theoretical question. What is the nature of the skills that are measured on an intelligence test? In particular, we want to know something about the mental ability that is involved when a person responds to test questions. Does an individual draw on a general fund of knowledge, or are many different abilities involved?

1. General versus Specific Abilities

One long-standing view of the structure of the intellect is that intelligence is a general capacity for reasoning and problem solving. Alfred Binet was one of the first people to articulate this view, though it achieved greater prominence in the work of Charles Spearman. An alternative view, first offered by Louis Thurstone, stresses that intelligence is primarily a set of individual abilities rather than a general trait.

To understand these two positions, we need to know something about a statistical technique known as factor analysis which originated with Spearman. **Factor analysis** is a statistical technique that allows the test constructor to determine if the various questions on a test are related to one another. In other words, does each question on an intelligence test require a separate mental ability, or are there groups of questions that require a similar mental ability/ to determine this, the investigator computes the correlation of each question with every other question on the test. Some question will correlate highly with each other but very weakly with other questions. Those that correlate highly with each other are said to belong to the same dimension, or factor. Once a factor has been identified, the investigator examines the questions that have clustered together to determine the nature (and the name) of the factor.

The strongest support for a single factor theory of intelligence is found is the work of Spearman. He believed that intelligence was composed largely of one major factor, which he labeled general intelligence, or simply g for short. In Spearman's view, all individuals possess g in varying amounts. Whether a person is bright or dull, that is, performs well or poorly on an intelligence test, is a function of g. Spearman believed that other factors, labeled s for special abilities, also exist, and that these abilities contribute to some of an individual's specific skills. But his primary emphasis was on the importance of g in determining intellectual performance.

Thurstone disagreed with Spearman's emphasis on a single factor of general intelligence. When Thurstone analyzed intelligence tests, he discovered seven different factors, which he labeled primary mental abilities. These **primary mental abilities** are verbal comprehension, numerical skills, word fluency, spatial visualization, memory, reasoning, and perceptual skills. Briefly describes each of these abilities. Eventually, Thurstone developed a series of a tests to measure these skills, known as the Test of Primary Mental Abilities. This test is still widely used, but in some ways it contradicts Thurstone's original hypothesis. The primary abilities, as Thurstone himself discovered, are not completely independent of one another. Instead, there are modest correlations among these abilities such that performance on one is somewhat correlated with performance

on the others.Other psychologists have also pursued the study of basic mental abilities. However, their estimates of the number of separate abilities vary considerably, depending on the investigator's procedures and the questions selected for analysis. In each case, however, the separate abilities show some relationship to each other, a result that tends to support a positions that is something of a compromise between Spearman's of a compromise between Spearman's and Thurstone's original viewpoints. Thus, the modern view of factor analysis holds that people do possess some form of general intelligence, but each individual will show a particular cluster of strengths and weaknesses. Practically speaking, this means that relatively small differences in IQ are not very meaningful. Two people whose overall IQ scores differ by only 5 to 10 points may be virtually indistinguishable from one another in terms of general intelligence. The person with the lower score may actually outperform the other in a number of situations. But when the difference in IQ becomes very large, for example 25 to 30 points the person with the higher scores can be expected to outperform the other individual on most tasks. A very large difference in overall test performance is usually an indication that two people differ considerably in their general problem-solving ability.

2.Triarchic Theory

The advantage of the factorial approach is that if offers psychologists a reasonably clear-cut model of the human intellect. It does not, however, address directly the question of how people actually solve complex problems. Over the past two decades a different approach, known as information processing, has examined how people encode, retrieve, and process information while solving difficult problems. Unlike the factorial approach, the goal of information processing is to determine what people do when confronted with complex problems-what strategies they use, what mental processes are involved, and how rapidly they achieve solutions.

Robert Sternberg is a psychologist from the information-processing tradition who has suggested that the traditional intelligence test captures only one important aspect of intellectual functioning. It should not be considered the sole indictor of how well people think. Rather, intelligence should be considered a multidimensional trait made up of three different abilities which Sternberg described in his triarchic theory of intelligence.

Sternberg proposed that one form of intelligence is shown when people solve verbal and spatial reasoning problems similar to those found on intelligence tests. Sternberg referred to this form as componential intelligence because it involves mastery of the sequence of steps, or components, that underlie the solutions to difficult problems. Componential Intelligence is highly adaptive in school situations, though as Sternberg notes it does not necessarily correlate with creativity and insight. However, a different kind of intelligence involves the ability to perceive novel and creative solutions to complex situations. Sternberg refers to this form as experiential intelligence and suggests that it is quite separate from componential abilities. That is, he believes that some individuals who possess only modest analytical skills (componential ability) are nevertheless highly creative and capable of very original work. Thus, experiential intelligence is likely to produce a sudden breakthrough in scientific research, or a novel form of artistic expression.

Finally, Sternberg noted that some people are particularly adept at knowing how to deal effectively with their environment. He referred to this as contextual intelligence because it involves a kind of street-wise knowledge critical to the practical problems that confront all of us. Contextual intelligence may be demonstrated by the individual who seems to have a knack for finding the perfect job, or the person who senses just the right time to ask for a promotion.

3. Multiple Intelligences

Psychologist Howard Gardner shares Sternberg's view that the factorial approach fails to capture the breadth and scope of the human intellect. However, in his provocative book, Frames of Mind, Gardner departs from the information-processing approach by including in his view of intelligence problem solving strategies that fall outside the traditional realm of mental abilities. Thus, unlike information processing theorists, Gardner believes that even nonmental abilities should be considered if one wishes to delineate the full range of intelligent behavior.

What Gardner proposes is a theory of multiple intelligences, using the plural form of the word quite deliberately. Gardner's principal point is that intelligence comes in many colors. There are the traditional manifestations of intelligence: linguistic, logical-mathematical and spatial abilities, frequently measured on an intelligence test. But there are three other types of intelligent behavior that are equally important though generally less valued: musical intelligence, personal intelligence, and bodily-kinesthetic intelligences. Gardner

believes that industrial societies have overemphasized the importance of the first three forms of intelligence and virtually ignored other manifestations of human problem solving.

Gardner's stated goal is to 'democratize the range of the human faculties" by stressing the value of other forms of intelligent behavior. He includes in his theory the kind of sensitivity to pitch and rhythm that leads to the ability to recognize and construct harmonious patterns (musical intelligence), bodily control and fine motor coordination, such as a surgeon or a ballet dancer might display (bodily-kinesthetic intelligence), and the facility both to perceive and understand the needs of others as well as to evaluate and monitor one's own emotions (personal intelligence).

The theories of Sternberg and Gardner represents a move away from the factorial analyses of intelligences that dominated psychological thinking through most of this century. While it is too early to know the fate of these new theories, it seems clear that Sternberg and Gardner speak for a growing number of psychologists who are interested in discovering the processes involved in human problem solving.

Pass Model of Intelligence

Extending the information processing approach, J.P.Das, Naglieri, and Kirby (1994) proposed this theory. The basic statement of the model is that intelligence can be understood as a result of interdependent functioning of three neurological systems: those responsible for arousal (and attention), coding (or processing), and planning. The two coding processes are simultaneous and successive. Thus the theory is known as Pass (Planning. Attention, Simultaneous, and Successive) Theory. The three components of Pass theory are shown in Fig.

Arousal and Attention: Suppose a young lady goes to market with her 3-year-old child. After some time the child becomes restless and also occasionally cries. This arouses the mother to attend to the child's needs.
Arousal is basic for initiating an activity. It forces one to focus attention in a particular direction. You have read earlier that attention is selective: You do not pay attention to each and every thing that comes on your way; rather, you attend to a few selected objects/ events/ persons which may be helpful in achieving the desired goal or are related to the desired goal or are related to the motivational state.

Simultaneous and Successive Processing: The mother realizes that her child is hungry and decides to take her to a restaurant. She looks at the shops around her. The shops have displayed different types of signboards. The mother attends to those signboards to find out a restaurant and tries to grasp their meaning. Here she uses simultaneous and successive processes to grasp the meaning out of the signboards. Simultaneous processes help you in grasping the meaning out of the pictures. This involves the integration of different stimuli at a time in groups and is holistic in nature. On the other hand, the mother reads the letters and words on after another written on the boards. Integrating the stimuli in series. In this case she is using successive processing to grasp the meaning. Learning of digits and alphabets Is another example of successive processing. Simultaneous and successive processes can be applied to the tasks of various modalities (auditory, visual, kinesthetic etc.) involving different kinds of stimuli (verbal or non-verbal). And may take place during direct perception, retention of information, and at higher cognitive levels.
Planning : After the attention and processing of information, you decide that this is a restaurant where you can get something to eat. If there are more than one, you select one of your choice, Thus, planning refers to generation refers to generation of plans or problems as well as to goal setting, strategy selection, and performance monitoring. Planning is responsible for activities such as asking questions, problem solving, and the capacity for self-monitoring.
Based on the pass theory, Das-Naglieri Cognitive Assessment System (CAS) was developed. The system employs verbal and non-verbal tests presented through visual and auditory sensory channels. It is appropriate for use with individuals between ages 5 to 11, and has been specially designed for use with intervention purposes. Some measures are given in Box 1.3. The system is considered an appropriate and innovative tool for the assessment of cognitive status.

Intelligence Tests- Measurement of Intelligence

Sir Francis Gal ton, who was a cousin to Charles Darwin, first explored the measurement of intelligence in 1884. Galton held two strong convictions about intelligence: (1) that intelligence was largely a matter of superior perceptual and physical attributes, and (2) that intelligence was inherited, with some families showing clear biological superiority over others. Accordingly, Galton reasoned that if he could determine which physical measurements (such as head size, muscular strength, and visual activity) correspondent to intelligence, he could demonstrate that intelligence was passed from one generation to the next. Unfortunately, after Galton had taken these measurements on more than 9000 subjects, he discovered that head size and other physical attributes were not related to intelligent behavior. These measurement failed to discriminate among people of known differences in intellectual ability. Thus, by the end of the nineteenth

century, psychologists abandoned the idea that perceptual and physical skills were the best indicators of intelligence.

1. Alfred Binet and the Measurement of Intelligence

Modern tests of intelligence emphasize the measurement of mental abilities, such as reasoning, remembering, and imagining. These abilities were first identified in the pioneering work of Alfred Binet, a French psychologist with a strong interest in how mental abilities differ from one person to another. Binet's fascination with individual differences stemmed in part from observations of his two daughters. Binet wanted to describe, in precise terms, the difference he saw in his two children and, consequently, gave them some of his first tests of mental ability.

Binet had been at work on the problem of measuring intelligence for some time when, in 1905 he was commissioned by the French government to devise a test that would distinguish children of average intelligence from those who were below normal. The government wanted to establish special classes for retarded children, but feared that teachers would be unable to evaluate their students objectively. Thus, the Ministry of Education called on Binet and his collaborator, Theophile Simon, responded with a 30-question test that became the forerunner of all modern tests of intelligence. The Binet-Simon test successfully distinguished retarded from normal children, thus confirming Binet's idea that abilities such as memory, imagination, and reasoning were better indicators of intelligence than were the perceptual-physical measurements developed by Galton.

The original Binet-Simon test presented questions in order of increasing difficulty. For example, a question in the first part of the test might simply require the child to discriminate between a square of chocolate and a square of wood. Later in the test, a child would have to determine which of two lines of slightly different length was actually longer. In 1905, Binet and Simon did not classify questions in terms of their difficulty for children of different ages. Indeed, one of the findings to emerge from their first test was that older children passed more questions than younger children. However obvious this now appears, it was an important step forward in the development of the concepts of mental age and the intelligence quotient (IQ).

Mental Age and IQ

As Binet and Simon revised their test, they began to learn about the average performance of children of different ages. For example, the typical 9-year-old could pass the following questions from the 1911 revision: name the months of the year, make change for 20 cents, and define five words at an abstract level. Through repeated revisions of their test, Binet and Simon eventually were able to classify questions according to age level ranging from 3 to 13 years. In so doing, Binet and Simon created the concept of **mental age (MA)**, an index of the child's problem-solving ability that is independent of the child's actual or **chronological age (CA)**. The distinction between MA and CA allowed Binet and Simon to determine how well a child performed on their test. An average performance was achieved when the child correctly answered questions designated as typical for his or her age. In this case MA and CA were roughly equivalent. When MA was substantially higher than CA, the child's performance was designated as above average. If the opposite held true (CA substantially higher than MA), performance was designated as below average.

The Binet-Simon test made such an enormous contribution to the study of intelligence that it was subsequently revised and used worldwide. Lewis, Terman, a psychologist at Stanford University, was the principal author of the first major revision in 1916. This test became known as the Stanford-Binet and was further revised in 1937, 1960, 1972, and most recently in 1986.

Although Terman was responsible for a number of major changes in the Binet-Simon test, his greatest contribution was to institute a numerical index that expressed intelligence as a ratio of mental age (MA) to chronological age (CA). this index, first suggested by the German psychologist William Stern, became known as the **intelligence quotient** or **IQ**.

The formula for the IQ is:

$$IQ = \frac{MA}{CA} \times 100$$

Thus, when MA and CA are equal, the formula yields an IQ score of 100, designated as the average IQ. When MC exceeds CA, the subject's performance is above average, while a CA greater than an MA yields a below-average performance.

Although the MA/CA formula was an important step forward, difficulties eventually arose. One particularly nettlesome problem is that mental age cannot continue to grow indefinitely. Intuitively, this makes sense because the growth of intelligence, like other human characteristics, much eventually begin to slow. However, as most adults will admit with some regret, there is no way to prevent the steady rise in chronological age. But if CA keeps increasing while MA levels off, IQ (defined s MA/CA) cannot help but decline as people grow older.

To solve this difficulty, psychologists developed a new procedure that classified people into groups of roughly the same age. Any individual who took an intelligence test was then compared to others in the same age bracket. Thus, IQ became a relative measurement comparing the test taker to people of the same chronological age. In this way, IQ is calculated by first setting a score of 100 as the average level to performance for a given age group. An individual's score is then converted into percentile that indicates how much he or she deviates from the average. On the present-day Stanford-Binet, for example, a score of 116 falls into the 84^{th} percentile, which means that an individual achieving this score has exceeded the performance of 84 percent of those in the same age group taking the test.

2. David Wechsler and Multiple Measures

We noted earlier that David Wechsler is one of the most prominent psychologist in the field to intelligence testing. He began his work over 40 years ago by disagreeing with Binet on one crucial point. In Binet's original test, and in subsequent revisions of the Stanford-Binet until 1986, questions were not organized into separate skill areas. This meant that an individual who took one of the earlier versions of the Stanford-Binet (prior to the 1986 revision) received only a single score.

Wechsler had a different idea about the measurement of intelligence. He believed test composed of a number of different abilities. Thus, he constructed an intelligence test that divided question into subscales measuring specific abilities. Wechsler then constructors should acknowledge explicitly that intelligence is a complex trait classified each subscale into one of two major scales: the verbal scale and the performance scale. This latter scale deals with the nonverbal measurement of intelligence.

Wechsler's interest in nonverbal intelligence arose from his work with patients at Bellevue Hospital in New York City. These patients were for most part poorly educated adults. For this reason, Wechsler felt that it was important to assess intelligence in a nonverbal way, through he did not wish to exclude verbal measurement entirely. The result of his efforts was an intelligence test measuring both verbal and performance abilities. This test became known as the Wechsler Adult Intelligence Scale, or WAIS (pronounced wace). A subsequent test measuring intelligence in 6 to 16 years olds was called the Wechsler Intelligence Scale for Children, or WISC (pronounced wisk).

We can use the WAIS-R to illustrate the basic format of all the Wechsler tests. Each question in the WAIS-R belongs to a single subscale that is designed to measure a distinct ability. The subscales belonging to the verbal scale measure abilities such as general information, word knowledge, comprehension of analogies, and the ability to evaluate and provide solution to everyday problems. The subscales belonging to the performance scale are generally concerned with spatial reasoning, perceptual and motor skills, and visual memory.

Test Construction

It takes a great deal of time and effort to construct an intelligence test. Before a test is accepted for use in the public domain, it must meet some very specific criteria. In this section we will consider three of the most important criteria: standardization, reliability, and validity.

I. Standardization

Standardization is the name given to the procedure in which, over the course of many months, an original list of question in administered to people of varying ages, races, and social backgrounds to determine which questions are suitable for the final version of the test. Through standardization norms are established. **Norms** are standards of performance for a large group of people that are used to compare an individual's score with the scores of others from a similar background. Thus, by consulting an appropriate set of norms a psychologists can determine how well an individual has performed relative to his or her peers.

The standardization procedure has two important goals. The first is to produce questions that discriminate or distinguish among people on the basis of age. This particular objectives has its roots in Binet's observation that, in general, older subjects should pass questions that younger subjects fail. Thus, if a question is answered correctly by both a group of 10-year-olds and a group of 8-years-olds, the question is probably inappropriate. On the other hand, if 80 percent of the 10-year-olds, 50 percent of the 8-year-olds, and 20 percent of the 6-year-olds answer a given question correctly, it is quite suitable for inclusion in a test. One purpose of standardization, then, is to produce question that vary in their level of difficulty for people of different ages.

A second goal of the standardization procedure is to ensure that questions are pre tested on people who are similar to those for whom the test is intended. If, for instance, the test is to be used in a country where 20 percent of the population is black, then blacks should constitute roughly 20 percent of the standardization sample. Since intelligence tests are administered to both males and females, test constructors also want to eliminate, or at the very least reduce to a minimum, sex differences in performance. Typically, this goal is accomplished by including equal numbers of males and females in the standardization sample and by analyzing their responses to prospective test questions. In similar fashion, a test that is standardized properly will also be sensitive to geographical differences (varying regions of a country) and urban versus rural life styles. Thus, proportionate numbers of people from different geographic regions and from urban and rural homes will be included in the standardization sample.

ii. Reliability

One important quality of a well standardized test is consistency. For example, if within a relatively short span of time a test is taken on more than one occasion by the same person, that individual should receive roughly the same score each time the test is administered. In such a case, psychologists would say the test has good **reliability,** defined as the extent to which a test yields a consistent, reproducible measure of an individuals performance.

One way to measure reliability is to test people on two different occasions separated by a relatively short period of time. This method, known as test-retest reliability, has figured prominently in the development of intelligence tests. Although an individual will not obtain exactly the same score on two different occasions, there should be relatively little variation in scores if the test is well constructed. On both the Stanford-Binet and the Wechsler scales, the tests-retest correlation for two scores obtained less than one year apart is approximately +.90. This high correlation (recall that the highest correlation coefficient is 1.00) indicates that both tests are reliable instruments.

There are other ways to measure reliability. Prominent among these is the procedure of determining the correlation between alternate but equivalent forms of the same test. If the question are well constructed, people should obtain roughly the same score on each form of the test. A variation on this method, known as split-half reliability, is to correlate answers to the odd-and even-numbered questions on a test. Of course, we should note that many factors can affect the consistency of test scores. For example, the subject's mood, physical condition, and motivation can have an effect.

iii. Validity

For a test to be of value to people, it must be clear that it actually measures what it is intended to measure. Thus, if a test is designed to assess intelligence, the test constructor must demonstrate that the questions on the test measure problem solving and not, for example, personality or some other characteristic that may be independent of intelligence. Such a demonstration gives the public confidence that tests do what they are intended to do.

Psychologists use the term **validity** to refer to the process by which a test constructor demonstrates that the test actually measures what it is designed to measure. In practice, this means demonstrating that a test achieves four different types of validity.

One form of validity, known as **predictive validity**, is a measure of how well a test forecasts some future event. This is perhaps the best-known example of validity, largely because intelligence tests were originally developed to predict one event in particular-success in school. Indeed, the original Binet-Simon test was successful primarily because it distinguished those who did well in school from those who did not. Subsequent intelligence tests, such as the Stanford-Binet and the Wechsler scales, are also highly successful in predicting school performing.

A second form of validity is **concurrent validity,** achieved when a positive correlation is established between scores on a new test and those on a similar test with a proven record. In other words, if a new intelligence test and a Stanford-Binet were administered to a large number of children, the children would have to perform similarly on both tests. Children who score high on one should score high on the other, and children who perform poorly on one should perform poorly on the other.

A third form is **content validity,** which means simply that the content of the questions on the test should reflect prevailing definitions of intelligence. For content validity to be established, a logical relationship must exist between the test questions and the concept they are intended to measure. If, for example, psychologists believe that intelligence involves the ability to provide solutions to everyday problem, then a question like "What is the advantage of keeping money in the bank?" has content validity.

A final form of validity is known as **construct validity**. This is achieved when a test produces results that are consistent with when is known about the concept or construct under investigation. For example, a common assumption about intelligence is that it increases with age throughout the childhood years. If a new intelligence test failed to show that older children generally achieve higher scores than younger children, it would not have construct validity.
It is worth noting that these separate aspects of validity are sometimes confused in discussion about the merits of intelligence tests. What intelligence tests do very well is predict future success in school. Most critics of intelligence tests acknowledge this point, but question whether the tests accurately assess the concept of intelligence. In other words, they challenge the construct and sometimes the content validity of the tests. Most psychologists have little doubt that intelligence tests can predict the school performance of children. The issue is whether the questions on an intelligence tests broadly and accurately sample what intelligence really is.

Test Performance

Two factors that play an important role in the outcome of any testing situation are competence and performance. **Competence** is the knowledge or skill that a person possesses. It is, in effect, the sum total of what an individual knows. **Performance,** on the other hand, is the knowledge a person demonstrates in a particular setting at a given moment in time. Because performance can sometimes obscure an individual's competence, psychologists have taken a special interest in identifying the factors that affect test performance.

A number of factors can influence performance on an intelligence test. Some examples are low motivation, uncertainty about what is demanded in the testing situation, or fear of the examiner. Psychologists refer to these as performance factors. Performance factors are personal characteristic of an individual, or circumstances surrounding the administration of a test, that can cause the individual to perform below his or her ability level.

Performance factors can influence any individual's test score, but thy are particularly likely to depress the scores of people who are unfamiliar or uncomfortable with testing situations. Economically disadvantaged children are among those who fall into this category, and their performance on intelligence tests is sometimes adversely affected by their wariness of the examiner. However, small adjustments can often undo these negative affects. For example, a short play period with the examiner prior to the administration of an intelligence test often leads to a significant improvement in the test scores of disadvantaged children.

Cultural Bias in Tests

Do people from all social and economic backgrounds have an equal opportunity to do well on an intelligence test, or do the tests favor people from some backgrounds more than others? At issue in this controversy is the fundamental question of whether intelligence tests are "culture fair."

If we take a close look at the question on most intelligence tests, it becomes clear that many of them reflect values and experiences more common to some people than to others. For example, certain questions about general information on the WAIS-R (such as, "Who wrote Hamlet?" and "What is the capital of Italy?") seem to fall into this category. Other questions involving verbal reasoning also reflect particular cultural expectations. A very poor person who is asked, "Why is it better to pay bills by check than by cash?" may be required to reason about a concept that is quite unfamiliar.

Serious concerns with regard to the effects of cultural bias led to the development of two alternative intelligence tests known as “culture-free” and “culture-fair” tests. These tests includes two general types of questions. One measured perceptual and spatial-reasoning abilities, which were thought to be less affected by cultural experience than most verbal questions. The other major category involved verbal reasoning about objects and events that were presumably familiar to people of all social and economic backgrounds. For example, a question on the Davis and Eells culture-fair tests might require a 7-year-old to state which two items in the following list are most similar: bread, chair, book, apple, and bird. What this question measures is the child’s ability to abstract the quality that makes apple and bread the most similar items on the list. The question is “culture-fair” because presumably all 7-year-old children have had some experience with each of the objects in this list.

The development of culture-fair and culture-free tests played an important role in reminding psychologists about the biases inherent in certain kinds of test questions. More recently, sociologist Adrian Dove emphasized this point quite dramatically when he developed a different kind of culturally biased test. Dove’s Counterbalanced General Intelligence Test, better known as the “Chitling Test,” was a methodological demonstration that a test can be constructed in a way that makes the majority, white culture appear disadvantaged. The question in Dove’s test are designed to capitalize on the language and experiences of minority children living in an urban setting. Other children, Dove speculated, would do poorly on such a test because the questions appear foreign or even bizarre.

The “Chiltling Test” clearly demonstrates that cultural bias is a relative notion. In certain situations, we all experience uncertainty about how to respond. But apart from this methodological point, does the “Chitling Test,” or something similar, offer a better assessment of an individual’s intellectual potential? The answer appears to be no. the problem is that tests like the “Chitling” do not have good predictive validity, that is, they do not forecast success in school even for minority children. Thus they do not do what intelligence tests have been designed to do since the time of Alfred Binet-identify those who need assistance in school.

We do not wish to imply, however, that the debate over cultural bias in intelligence tests has settled completely. Psychologists continue to question whether the traditional intelligence test is a fair assessment of the intellectual potential of people who are not art of the majority culture. Some authors have suggested that the solution to the problem is to use a broader battery of tests when assessing the intellectual skills of poor and minority group individuals. One illustration of this approach is Jane Mercer’s System of Multicultural Pluralistic Assessment, more commonly known as SOMPA. The SOMPA assessment, designed for 5-to 11-year-old children, gathers information from several sources: (1) a WISC-R yields a traditional measure of the child’s intellectual functioning; (2) a parental interview provides information about the family’s social and economic background; (3) an adaptive behavior inventory measures the child’s social adjustment to school; and (4) a medial exam ascertains whether the child has any physical problem that might hinder performance in school or on tests.

The purpose of the SOMPA battery is to broaden the traditional assessment of intelligence. For example, if a child from an economically deprived background performs poorly on the WISC-R, this is considered but one aspect of his or her intellectual ability. The child’s score on the adaptive behavior inventory is also taken into account, along with information about the child’s health and living conditions.

The SOMPA assessment differs from the Cattell and the Davis and Eells tests in that it makes no attempts to develop question that are fair to all groups. On the contrary, SOMPA tries to take into account cultural and economic experience that may influence performance on traditional IQ tests. The goal is a “culture-adjusted” rather than a “culture-free” test.

Extremes of Intelligence

A score of 100 is the average performance on most intelligence tests. However, because very few people obtain this exact score, it is important to consider variations around the average. For example, on the Wechsler tests the score of 68 percent of the population fall between 85 and 115. Almost the entire population (95 percent) receives a score between 70 and 130. Beyond these two extremes lies a small number of people who represent two distinct groups: the mentally retarded and the intellectually gifted.

1. The Mentally Retarded

Historically, mental retardation has been defined by the score that a person obtains on a standardized intelligence test. The exact score, however, is somewhat arbitrary. In 1959, the American Association on Mental Deficiency (AAMD) used an IQ of 85 as the cutoff point for normal intelligence. Anyone below this

level was considered retarded. But in 1973, the AAMD changed the cutoff score to 70. In so doing, millions of people who would have been considered retarded by the old criterion no longer were classified as such. These shifting criteria demonstrate that the dividing line between normal intelligence and mental retardation is somewhat flexible.

More importantly, the AAMD now recognizes that low intelligence is but one indicator of mental retardation. An equally significant criterion is a deficiency in adaptive behavior. To be considered mentally retarded, then, an individual must have an IQ below 70 and demonstrate an inability to meet the standards of personal and social responsibility expected of his or her age group. Moreover, this intellectual and social deficit must occur for the first time before age 18. People who become incapacitated in adulthood through brain injury or disease are not considered mentally retarded.

The AAMD recognizes four distinct levels of mental retardation: mild, moderate, severe, and profound. These are defined by a combination of an intelligence-test score and the judgment of a psychologist about the individual's adaptive functioning. To judge adaptive functioning, psychologists often refer to a set of general guidelines that help identify the level of retardation. The criteria of psychologist would use in classifying the adaptive behavior of a retarded adolescent. These criteria are then combined with IQ scores to yield a classification system for mental retardation. One such system, based on norms provided by the AAMD.

Before turning to the question of what causes mental retardation, we want to consider an important point about the four levels of retardation we have just described. There is a widespread misunderstanding of mentally retarded individuals that borders on a stereotype. Many people believe that virtually all **retarded individuals are seriously impaired in their everyday functioning. In fact,** the great majority of retarded people are classified as having only mild retardation. In practical terms, this means that while the retarded are deficient in academic skills, most are capable of holding jobs and can deal adequately with many social situations. The term mental retardation should not conjure up an image of a helpless are incapacitated person.

Causal factors of mental retardation

By current estimates, somewhere between 2 and 3 percent of the United States population (roughly 6 million people) is mentally retarded. Generally speaking, the causes of their retardation may be divided into two categories: organic retardation and psychosocial retardation. The basic distinction between the two is that organic retardation has a physiological basis (such as chromosomal damage, metabolic disorders, or injury to the brain), while psychological retardation has no obvious physiological cause but still afflicts more than one member of the same family.

Perhaps the best-known example of organic retardation is Down syndrome, so called because the physical characteristics associated with this disease were first described by the English physician Langdon Down. **Down syndrome,** which affects roughly 1 out of every 700 infants, results from a chromosomal abnormality in which the child has one more chromosome than normal. The Down syndrome infant typically has a round face with a low-bridged nose, a thick tongue that often protrudes slightly, and almond-shaped eyes that slant upward. Children affected with the disorder typically begin to walk late, and many have congenital heart problems that can result in an early death. Intellectually, they have a rather wide range of subnormal IQ scores, while on an interpersonal dimension they tend to be outgoing and friendly.

The other major form of retardation, psychosocial, is associated with living conditions that depress the expression of intelligence. Several independent studies have shown that children raised in deprived and impoverished conditions have low IQ scores, often in the 50-70 range. While such findings suggest that an inhospitable environment is the essential cause of psychosocial retardation, some psychologists have pointed out that other children from similarly deprived backgrounds have normal IQs. This suggest that the environment per se may not be the sole cause of retardation. These experts feel that subtle organic or genetic factors may still play a role in the development of psychosocial retardation.

2. The Intellectually Gifted

On the opposite end of the intellectual continuum is a small group of people who are of superior intelligence. These people have IQ scores that equal or exceed 130, and, like the mentally retarded, they represent roughly 2 to 3 percent of the population as a whole. These people are the intellectually gifted, who in addition to a high IQ, often have a particular talent that clearly sets them apart from others.

Lewis Terman, who was involved in the development of the Stanford-Binet intelligence test, began a monumental study of gifted children in 1921. Terman selected over 1500 subjects between the ages of 3 and 19 whose IQ scores exceeded 135. With the help of a number of associates, Terman conducted follow-up studies on these subjects every 5 to 10 years. The most recent observations were made in 1972 when these gifted subjects were entering their 60s.

From this wealth of data, Terman made some discoveries that contradicted commonly held belief about highly intelligent people. He discovered, contrary to popular belief, that high intelligence is not routinely associated with an odd or eccentric personality nor with a frail or weak constitution. Quite to the contrary, when these intellectually gifted people were compared to age-mates of average intelligence, they were superior in health, physical size, social adjustment, and achievement. Furthermore, superiority on these dimensions was a stable phenomenon that continued throughout the adult years. As you would expect, many gifted individuals graduated from college and secured successful positions in professional fields, but their marital and social lives were no more tangled than those of their normal counterparts. Life adjustment for the gifted was about the same as it was for the general populace.

Although few people dispute Terman's findings, the interpretation of the findings has caused considerable disagreement. Some psychologists believe that the relationship Terman discovered between high IQ and general success in life demonstrates the value of the intelligence test in predicting future accomplishments. Arthur Jensen, a staunch defender of intelligence test, argues this point when he suggest that Terman's data firmly establish the power of intelligence test to measure characteristics of great important to our modern technological society. Jensen wrote. "To say that the kind of ability measured by intelligence test is irrelevant or unimportant would be tantamount to repudiating civilization as we know it".

Psychologists on the other side of the issue are less in awe of the intelligence test. David McClelland, a prominent member of this group, directly challenged Jensen:

One of McClelland's primary concerns was the particular sample of people Terman chose to study. They were predominantly white, middle –to upper-middle –class individuals who came from superior social and economic backgrounds. Quite apart from their native intelligence, these people enjoyed access to the professional and social networks that are conductive to success in life. In short, McClelland believed that Terman had failed to control for opportunity, and therefore nothing of consequence could be said about the value of IQ scores in predicting life's accomplishments.

Because the disagreement between Jensen and McClelland involves a basic question about the role of intelligence test, it cannot be resolved completely through a single study. Nevertheless, it is worth noting that one aspect of Terman's data supports McClelland's arguments. Terman's had noted that not all of the gifted children were successful, and had divided his sample into "more successful" and "less successful" groups. While the IQ scores of these two groups were very close (average adulthood IQ of 139 for the more successful and 133 for the less successful group), there was a considerable difference in one aspect of their family backgrounds. Many more people from the successful group had a stimulating intellectual environment during childhood and had fathers who were college graduates. Such a finding implies that family background was an important factor in determining who belonged to the more successful group.

Stability and Change in IQ

We noted earlier than in absolute terms mental abilities increase throughout the early portion of the life span. Older children, for example, generally know more than younger children. But we have also stressed that IQ is a relative measure of intellectual ability, comparing the performance of one person to others of the same age. Thus, psychologists have inquired whether IQ can change substantially over the years, or whether people with high or low IQ scores in childhood continue to maintain their relative standing as they grow older. In other words, is a person's IQ largely fixed and unchangeable, or can one experience considerable change in IQ over a long period of time?

Most people experience relative stability in IQ by the time they are approximately 4 years old. For example, the figure given below shows the correlation between mental-test scores at 17 years of age with scores obtained in the previous years beginning at age 1. The information is based on the results of the Berkeley Growth Study, a large scale project that involved extensive mental testing of children from birth through adolescence. Note that correlations with test performance at age 17 do not become stable (approximately +.45) until roughly age 4. From this point on, the relationship becomes increasingly stronger, and by age 7 there is already a very high correlation (roughly +.70) with performance at age 17. in general, then, an individual's IQ at age 7 is a fairly good predictor of that person's IQ at age 17.

While most people follow the pattern shown in fig some individuals show major changes in their test performance over a long period of time. In many studies, for example, children who were tested from birth into adulthood showed shifts of 15 IQ points or more even after age 7.Although we do not completely understand why these occur, experiences in the home environment seem crucial. For example, McCall et al. identified two groups of children who showed marked changes in IQ scores. One group, whose parents often attempted to accelerate development by training children in various mental and motor skills, showed increased scores during the preschool years. By contrast, the parents of the second group of children, whose scores decreased sharply in the same period of time, rarely attempted to accelerate development.

Heredity, Environment, and Intelligence

A question repeatedly asked of psychologists is whether a person's intelligence is largely attributable to genetic factors, or whether environment is the major determinant of intelligence. However convenient it may be to think of intelligence in these either-or terms, modern psychology does not support such a distinction. Both heredity and environment contribute to an individual's intelligence. As Anne Anastasi (1958) remarked in a famous paper on this subject, the question is not which is more important –heredity or environment –but rather how the two interact. Determining how heredity and environment interact to produce something as complex as intelligence is not simple matter. We cannot identify all of the environment factors that contribute to the development of intelligence, not do we yet know enough about genetics to describe the complex relationship between genes and intelligence. However, we can review the evidence that has suggested to psychologists that both heredity and environment play important roles in intellectual development.

The simplest way to investigate the heredity-environment relationship is to employ family resemblance studies which examine the correlation in intelligence-test scores among people who vary in intelligence-test scores among people who vary in genetic similarity. One such investigation was conducted by Bouchard and McGue (1981) who carried out a worldwide literature review that identified 111 family resemblances studies.
A striking feature of the data in table is that as genetic similarity between people increases, so does the correlation in their IQ scores. Cousins, who share roughly 1/2 percent of their genes, have a correlation in IQ scores of + .15. The next three entries in the table –parents, siblings, and fraternal twins (who develop from separate eggs) –all share roughly 50 percent of their genes. Note that the correlation in IQ scores for each of these groups is to close to + .50, except when siblings are reared apart. But identical twins, who develop from a single fertilized egg and share 100 percent of their genes, have a correlation of + .86 when reared together and + .72 when reared apart. This pattern of results suggests that heredity makes a strong contribution to an individual's performance on an intelligence test.

Table
Correlation in IQ scores of people varying in genetic similarity

Cousins	+.15
Parents and children	+.40
Siblings reared apart	+.24
Siblings reared together	+.47
Fraternal twins reared together	+.60
Identical twins reared apart	+.72
Identical twins reared together	+.86

But environmental influences are also at work, and though it may be less obvious, the results demonstrate this fact as well. Note that for each of the relationship in this table in average correlation coefficient is higher when individuals reared together. This finding suggests that the home environment contributes meaningfully to the development of intelligence. Furthermore, it is quite possible to overestimate the role of heredity based on the results shown in the table. For, example suppose the individual environments of twins reared apart are really quite similar. This frequently happens because twins are usually separated when the need for adoption arises, and because adoption agencies typically places twins into similar adoptive homes. Thus, twins who are reared apart may still experience very similar intellectual environments, and this will contribute to the similarity in their IQ scores.

Studies of adopted children are every useful to psychologists examining the heredity-environment relationship. For example, investigators can determine the correlation between the IQ scores of adopted children and their two sets of parents: birth and adoptive. A review of a number of these studies showed that the average correlation between adopted children and their birth parents, +.48, was considerably higher than the average correlation between adopted children and their adoptive parents, +.19. although these results seem to indicate that heredity plays the stronger role, we cannot draw such a conclusion without examining environmental influences more closely. To do this, psychologists have studied both the intellectual

environment of foster homes and the length of time that adopted children have lived with their foster parents. For example, Scarr and Weinberg conducted a “transracial” study of 101 white families who adopted black children. The parents in these families were well above average in intelligence, income, and social class. The children adopted into these homes scored considerably above the average IQ of 100. furthermore, children who were adopted early in life (within the first year) had higher IQ scores than those adopted later. Such findings suggest that when adoptive homes provide a superior intellectual climate, they can have a substantial effect on intelligence.

Heritability

We have reviewed evidence indicating that both heredity and environment influence intelligence. But is there a way to gather information on the relative contribution of these two variables? Some psychologists believe that a statistical technique known as the **heritability ratio** provides a useful estimate of how much of the variability (roughly the range) of IQ scores is due to heredity and how much is due to environment. While the mathematical assumptions of this statistic are quite complex, the basic idea is that IQ scores can be proportioned into two parts-a part due to heredity and a part due to environment. And, at least in theory, these parts can be assigned rough percentages, so that one may hear psychologists talking about estimates such as 80 percent of the variation in IQ scores due to heredity, or 40 percent due to environment, and so forth. These somewhat mysterious figures are generated by the heritability ratio.

In discussing heritability, we want to emphasize two crucial points. First, the heritability notion applies only to a population or group of people and not to any single individual. A great deal of confusion arises when this distinction is ignored. We cannot say, for example, that 80 percent of an individual’s intelligence is determined by heredity. What the heritability ratio indicates is that for a particular group of people measured on a particular test, some proportion of the total variation in their test scores is due togenetic factors. A second and equally important point is that although we speak of a heritability ratio, this statistic actually reflects both the genetic and environmental factors that existed when the test scores were obtained. If, for example, the environmental conditions in the population changed radically (for example, if a group of people were suddenly placed in more intellectually stimulating environments), the heritability index could shift dramatically. The word heritability does not imply that intelligence is fixed and unchangeable. The heritabiity ratio is simply a measure of the relative contribution of genetic factors for a particular group of people at a given point in time. Thus, if the heritability ratio was computed on the adopted children in the Scarr and Weinberg transracial study at two points in time, just after adoption and many years later, we could expect two different outcomes. The experience of living in a superior intellectual environment might very well alter the ratio.

Race and Intelligence

The heritability ratio has become entangled in one of the most bitter scientific disputed of the twentieth century. The focal point of this dispute, a difference in the average performance of black and whites on standardized intelligence tests, is a well established finding that is not seriously questioned by anyone. A number of studies have shown that the average IQ score for the white population is approximately 10 to 15 points higher than the average for the black population. What is controversial is not the difference, but how the difference should be interpreted.

Perhaps no single paper has done more to keep the controversy alive than **Arthur Jensen’s** monograph on intelligence and educational practice. Jensen’s long and scholarly argument was principally a discussion of genetic and environmental components of intelligence. Only a small portion of the paper was devoted to racial differences in intelligence, but what Jensen said about these differences made the paper a major target of criticism from biologists and psychologists alike. In his paper, Jensen reviewed a series of twin studies similar to those we discussed earlier. On the strength of this review, Jensen concluded that the best estimate of the heritability of intelligence as +.80. This estimate, though somewhat high, is within the range obtained by other investigators. However, the controversy was over Jensen’s hypothesis that the average performance of black and whites on standardized intelligence tests might be due to genetic factors. Although Jensen took care to note that this hypothesis did not apply to any single individual, his suggestion that the average differences in test scores between the races might be due to average differences in genetic endowment touched off a passionate debate.

What is the current status of Jensen’s hypothesis? Jensen continues to believe that the hypothesis is viable, but he has a number of opponents who have advanced a wide range of counterarguments. These arguments

generally fall into one of two broad categories: those based on the inequities in the general experiences of black and whites and those based on the meaning of race and the proper interpretation of the heritability ratio. For example, psychologists who subscribe to arguments of the first category have noted that blacks often experience less adequate physical are than whites, even when compared to whites in the same social class. These effects may very well be compounded by differences between black and whites in family structures, educational background, and perceived opportunity for success. Black children are known to show greater levels of anxiety in formal test-taking situations than white children, report less motivation to do well on the tests, and show marked improvement in their test performance when the examiner takes longer than usual to establish good rapport. Obviously life experiences can influence the test performance of blacks in a rather dramatic way.

Biologists have raised other serious questions about Jensen's hypothesis, including whether black and whites actually represents distinct racial groups. Although the two groups differ in genetic constitution, there has been considerable crossbreeding. According to one estimate, the black population "may have received 20 to 30 percent of [its] genes from the white population". In fact, differences in genetic constitution are much more variable within racial groups than between racial groups.

But perhaps the most serious issue that biologists have raised is the proper interpretation of the heritability ratio. We noted earlier that this ratio is a group of population statistic. It is computed on a particular group of people and, as we pointed out, is subjects to change if conditions is the environment change. But the ratio was nothing whatsoever about difference between groups or populations. The heritability ratio must be computes separately for each population that is studied. There is not way to compare different populations because the ratio is computed under different conditions (for example, the environmental experience that foster intelligence) for each group. Even if the heritability of intelligence was high in both black and white population, the actual differences in average test scores might be due to environmental factors, to genetic factors, or to some combination of environmental and genetic factors. In other words, simply because the heritability ratio is high for both groups, we cannot conclude that differences in average test scores between the groups are due to heredity. Thus, in the eyes of many biologists, the heritability ratio is an inappropriate tool to make comparisons between races.

Intelligence Testing-Uses and Alternatives

Before concluding our discussion of intelligence, we should turn to one very compelling question: what are the proper uses of the intelligence test? This is a simple but far reaching question about the role of IQ testing in society. It is all the more compelling when we contemplate some early misuses (and misinterpretations) of intelligence tests.

Early Uses of Intelligence Tests

At the turn of the century, a large number of became concerned about the problem of allowing unselected masses to enter the country. In response to this concern, psychologists Henry Goddard was called upon to screen the immigrants using the newly development mental tests. Although there was an obvious difficulty with language and cultural barriers, Goddard believed that the tests could be translated and then used effectively as screening devices. In the years that followed, a number of potential immigrants were deported or refused admission because they were classified as "feeble minded" on the basis of these entrance tests. Authorities failed to recognize the very real possibility that the tests in no way measured the immigrant's true abilities.

A similar unhappy chapter in the history of intelligence testing can be found in several early discussions of the IQ data collected by the U.S. Army during World War I. During the war, the Army tested millions of draftees, including large numbers of immigrants from many different European countries. When prominent psychologists of the day analyzed these test results, they were looking for patterns that would show national superiority rather than the performance factors that might have influenced the outcome. Thus, they spoke about the superior intelligence of people from Scotland, England, and northern and western European countries, and the rather inferior abilities of those from southern and eastern Europe, such as Italians and Russians. Overlooked in this analysis was the question of how long the immigrants had lived in the United States before they were tested and thus how familiar they were with the American language and culture. In fact, when the scores of immigrants who had lived in the country 20 years or more before testing were compared with those of native-born Americans, no meaningful differences were found. But psychologists of that era ignored a cultural interpretation in favor of one that stressed the superiority of certain "blood" lines, such as Nordic blood over Mediterranean blood.

Although such flagrant abuses and misinterpretations of the intelligence test no longer occur, some psychologists remain concerned that IQ testing, particularly as part of a selection process, is less fair to some people than to others. This is one reason for the caution and concern that surround the contemporary use of intelligence tests.

Contemporary Uses of Intelligence Tests

In today's society, one of the most positive uses of an intelligence test is to help people resolve difficulties and make decisions about their lives. For example, an individual might approach a psychologist about a specific problem, such as reading difficulties in the classroom. In such a case, the psychologist may need to know something about the individual's general intellectual capabilities and may use an intelligence test as one part of the diagnostic procedure.

A far more controversial use of the intelligence test involves selecting people for a particular station in life, such as whether to take college preparatory or general courses in high school, or whether to pursue a particular job or career. One reason such uses of the intelligence test are controversial is that the consumers, those who are being tested, have usually not requested the test. In these instances, then, the psychologist is really acting on behalf of someone else. A second and more compelling concern is the fairness of the intelligence test to all those competing for a particular educational or vocational opportunity. As we noted earlier, many psychologists question whether the intelligence test provides an accurate assessment of the intellectual capabilities of people from all economic and racial backgrounds, especially when the goal is to select individuals for particular jobs. These experts believe that in cases where assessment is required, a more equitable tool must be found. While some psychologists defend the use of intelligence tests as objective instruments that remove the potential for personal bias from the selection process, there does not appear to be sufficient confidence in the tests to warrant their exclusive use when choosing people for particular educational or vocational positions.

In this regard, it is interesting to note the findings of a recently completed 4-year study of standardized tests by the National Academy of Sciences. This prestigious body concluded that standardizes tests, including intelligence tests, show strong predictive validity and can often be quite helpful in forecasting how well a person will do in school or on the job. However, the Academy qualified this cautious support for testing with the warning that tests should nerve be considered the sole measure of a person's ability. The report stated that although tests have "severe limitations," they create a fairer and more objective climate than would a situation in which no tests were used. The essential argument of the report is that tests must be used wisely. For example, in most school systems intelligence tests are now used primarily to determine if a student needs remedial help. Academic suggests that this is a legitimate use of intelligence tests but warns that tests scores alone should not be used to classify a student as below normal. Information from other sources, such as teacher reports, should also weight in the decision. In addition, any classification of a child based even partially on test results should be subject to periodic review.

The question that confronts psychologists today is how to use intelligence tests effectively. Do they have any social value or should they be abolished altogether? The answer seems to be qualified where individuals need help, particularly with school-related activities, intelligence tests can be useful as one part of a broad-based assessment. They should not be regarded as the sole measure of intellectual capability, as the National Academy of Sciences report suggests, but they can provide a helpful profile of an individual's strengths and weakness. In this regard, we note that in many situation psychologists do not focus exclusively on a person's overall or full scale IQ but examine the pattern of scores on the various subtests. Thus, often the psychologist's goal is to provide an extensive evaluation of an individual's abilities, not simply a single number that represents an estimate of general intelligence. In short, when used sensibly and interpreted cautiously, the intelligence test can play a productive role in the decisions people make about modern-day problems.

Special Abilities or Aptitudes: Nature and Measurement

An aptitude is a combination of characteristics that indicates an individual's capacity to acquire some specific knowledge, or skill, after training. It simply states that you need to possess various qualities in different proportions to learn or become something, such as to acquire ability to speak a language, to become a musician, to do some mechanical work, and so on. These qualities can be harnessed by appropriate training. In other words, if a person does not have the special abilities required to become a musician, such as discrimination between pitch, tone, rhythm, and other aspects of musical sensitivity, he/she would not be a musician, even after sufficient training.

There are salient differences between intelligence, aptitude, and achievement. Intelligence refers to the ability of a person to do certain things at a given time. Aptitude refers to the potential ability of a individual to

perform a task, which generally consists of a combination of abilities. Achievement involve performance at any given point of time in a particular subject with which you have been made familiar.
Aptitude tests, because they are concerned with the potential of doing something, are used for prediction. Many aptitude tests, such as clerical aptitude, mechanical aptitude, musical aptitude, typing aptitude, etc, have been developed to predict success in specific professions. Each of these tests usually contains a number of sub-tests. Several multiple aptitude tests batteries have been developed. In a Multiple Aptitude Test Battery the examinee is tested in several separate, homogenous aptitude areas. Prominent aptitude tests batteries are: The Differential Aptitude test (DAT), the General Aptitude Test Battery (GATB), and the Armed Services Vocational Aptitude Battery (ASVAB), etc. Salient characteristics of one of the batteries most often used in educational settings are described here.

The DAT was first developed to provide a basis for the educational and vocational guidance of students for grades 8 through 12. subsequently, it has been found useful for vocational counseling of young adults out of school and in the selection of employees. It consists of eight independent sub-tests:

Verbal Reasoning (VR)
Numerical Ability (NA)
Abstract Reasoning (AR)
Clerical Speed and Accuracy (CSA)
Mechanical Reasoning (MR)
Space Relations (SR)
Spelling (S)
Language Use (LU)

J. M. Ojha has developed an Indian adaptation of the DAT. In addition, a number of aptitude tests have been developed in India for measuring scientific, teaching, clerical, engineering, scholastic, medical, literary and other aptitudes.

Let us understand the nature of some of the tests, which are used for aptitude testing. Mechanical Reasoning: This test attempts to predict success in fields involving repair of autor, refrigerators, air-conditioners equipments, and the like.
Verbal Skills: This test measures a person's interest in and knowledge about words. It is assumed that a person who scores poorly in this area will not do well in occupations requiring a great deal of reading and writing.

Clerical Speed and Accuracy: It attempts to measure some of the skills necessary in clerical and office jobs. This is a timed, speed test because such a job require speed with which one works.

Generally, the tests measuring different aptitudes are grouped together n the form of a Test battery. The battery of tests is administered to the client for counseling.

Vocational Guidance and Aptitudes

Two vocational counselor is concerned with the problem of advising or assisting individuals in their choice of appropriate occupational goals and counseling them in the development of plans for progressing toward the attainment of such goals. To do this most efficiently, it will be necessary for him to have information relative to the individual's vocational interests, aptitudes, proficiencies, and personality traits. There is no single test, procedure, or other basis for determining one's potential fitness for an occupation. The vocational counselor must seek data from the school records, interviews, personal history, and objective tests. In this connection Berdie has stated, "abilities and interests are the codeterminers of achievement, whether it be vocational, educational or athletic."

For most junior-and senior-high school pupils there are two very important periods for the appraisal and evaluation of their abilities and aptitudes as a basis for educational and vocational selection. The first should be at the end of junior-high-school period so as to provide a basis for the development of further educational plans in relation to vocational selection. The second appraisal should be made at the twelfth-grade level or prior to separation from school. There is a definite trend in this connection toward assisting students in the evaluation of data related to their aptitudes and proficiencies. These are then studied by the student and counselor in relation to job families and special occupational requirements. Profiles are constructed to show the various characteristics and abilities in a more comprehensive manner. Such a procedure, whereby the student is guided in analyzing his test results, is definitely in harmony with the democratic principle of individual responsibility in the selection of a vocation which will provide for him the optimum satisfaction.

Aptitudes for Manual Work

There is a prevailing notion that the bulk of individuals comprising the manual occupational group are of low intelligence and unfit for any other type of work. Army studies of enlisted men who gave as their occupation manual labor show that this is by no means true. While the majority of this group is recruited from the lowest 30 or 35 per cent on intelligence, test scores, it will be found that many manual jobs offer real opportunities for advancement and job satisfaction to individuals above average in intelligence, provided they have other qualifications which contribute to aptitude for the job. Furthermore, unskilled and machine-tending jobs may not demand a high degree of skill or of scholastic aptitude, but may require of the worker such qualifications as dependability of character, stamina, and other abilities related to character or muscular physique. If these qualities are essential for the successful performance of a job, they should be regarded as aptitudes for the task and considered in vocational selection. A person entrusted with tending to an expensive machine may not necessarily have the aptitude for learning seventh-grade science and social science so as to meet standard school requirements; he may not have the finger dexterity or motor co-ordination essential for highly skilled activities; but if he can be counted on to oil the machine at a specified time, to be on the job promptly, and perform other elementary activities according to general directions he will be a valuable worker with the aptitude for the job. Such an aptitude can best be determined from the past performances. It is for this reason that a personnel record of the work habits of the worker provides a good basis for determining future work habits. Such a record should not be omitted from a consideration of vocational selection in relation to any of the vocations discussed throughout this chapter.

Tests of Manual Dexterity. The extent to which manual dexterity exists varies with different manual activities. Tests are of two general types. One type measures hand and finger movements alone. The O'Connor Finger and Tweezer Dexterity Tests are of this type. The Finger Dexterity Test consists of a metal plate with one hundred holes each large enough to hold three metal pins. With one hand the subject picks up three pins at a time and inserts them in one hole. The Tweezer Dexterity Test is similar in nature to the Finger Dexterity Test except the subject picks up one pin at a time with a pair of tweezers and places it in the hole. The other type consists of those tests measuring the ability to manipulate the arm, together with hand and finger dexterity of a less delicate nature. The Minnesota Manual Dexterity Test is an example of this type. This test measures the speed with which a person picks up and places 58 cylindrical blocks, all of the same size, in holes in a board. The holes are arranged in rows of four except for the first and last row, where there are three. This test differs from a form board in that it requires no spatial factor, but measures only manual speed. However, form boards have been used for estimating dexterity necessary in certain types of manual work.

The nature of the manual task to be performed should determine the choice of a test to be used. There are many and motor tests available for measuring strength, speed, and co-ordination. The apparatus known as the Stanford Motor Skills Unit developed to measure relatively independent motor skills which may be indicative of aptitude for different manual skills. Such a battery of tests should be a great value in vocational selection for manual and semiskilled tasks requiring different patterns of aptitudes.

Aptitudes for Industrial Skills

Occupational Ability Patterns. That occupational ability patterns exist is the plausible assumption which has led to the increased use of scientific techniques for job analysis, for studying the individual and for conducting programs for vocational guidance. There are as many personality patterns as there are individuals, and there are innumerable combinations of job characteristics. The function of tests, rating scales, interviews, and other standard personnel devices is to find those individual occupational profiles that will harmonize with the description of certain occupations. A thorough job analysis and a battery of tests established on the basis of such as analysis must consist of items that detect the various elements for the complete skill. A study of the details of the different tests will reveal whether or not the subject has the abilities vital to the performance of the industrial task. All industrial work, consequently, has some of the characteristics of a Procrustean bed-some must stretch to fit it, others must squeeze themselves into a constricted frame, and a few will be found to fit just right.

The Employment Stabilization Research Institute of the University of Minnesota made use of a method earlier devised by Link for determining the patterns of traits required of workers on different occupations. This pattern was determined by administering a group of psychological tests of experienced workers on the job and then describing the psychological qualifications for the job in terms of the scores obtained.

It has been pointed out that the use of such a procedure is based on the following implications: (1) the existence of unitary traits, (2) the existence of tests that are valid for measuring each of these traits, and (3) that these traits reveal differential occupational patterns. If there were a single factor underlying all mental traits, the problem of testing mental traits related to the various occupations would be simplified. However,

evidence from the studies by Thurstone and others in this area supports the theory of unitary traits. In connection with the selection of tests for a specific occupation, the experimenter should strive to secure tests that correlate closely with the criteria for occupational success but do not correlate with each other. When tests correlate closely with each other, this is good evidence that they are measuring the same unitary trait or traits.

There is some evidence that generalizations drawn from the third implication are not valid in all situations. When test scores obtained from a battery of tests are used for predicting vocational success, one is likely to find some successful workers making low scores and some less successful workers making high scores. Various theories may be introduced as an explanation for this. It appears, however, that the most plausible explanation is that the successful performance on a job may be attributed to the pattern of traits existing rather than the total quantity or score obtained from a battery of tests. Thus, increased attention is being given to psychological profiles and trait patterns.

The Use of Intelligence Tests. Intelligence testing has an important place in industry for the measurement of aptitudes for varying levels of ability to learn and to accept responsibility. If such tests are given to workers already employed, and the range of scores is obtained for successful workers at different jobs, such ranges will provide a good basis for selecting workers with the optimum intelligence levels for the different industrial activities. Many intelligence and general aptitude tests are available for industrial use. The Wonderlie Personnel Test, and adaptation from the Otis Self-Administering Test, is especially suitable to the needs of business and industry. This test was developed by selecting those items from the Otis test that were found from trial experiences to differentiate best the superior from the inferior employees on various tasks in business and industry. Studies show considerable variation in the effectiveness of intelligence tests in selecting workers for different jobs or even for similar jobs with different industrial or business concerns. Although a number of factors may account for this, it appears that the job and worker specifications for a particular job will vary from one establishment to another.
A substitute for intelligence testing in the selection of workers from applicants who have passed certain educational requirements. Since intelligence is an essential factor for the successful learning of complex educational materials, this becomes an indirect method of selecting applicants on the basis of intelligence. The policy of selecting workers for routine industrial jobs from high-school graduates, when a large supply is available as was the case during the 30's, is unsound. Such a policy inevitably leads to considerable job dissatisfaction and family labor turnover when jobs more intellectually challenging are available to these employees. In this connection Tiffin points out the following:

It should be re-emphasized at this point that the primary function of mental ability tests in industry is to help the employment manager in his placement of employees. Adequate placement means that some jobs should be filled by high-scoring individuals and that other jobs should be filled by low-scoring individuals.

Mechanical Abilities. Within the field of manual and motor skills certain proficiencies in the use of tools, speed and accuracy in manipulation, and the ability to assemble small common mechanical gadgets into a known pattern are grouped together as mechanical abilities. Various tests have been designed to measure these abilities. Some of these were jobs. In addition to these tests for measuring certain more or less specific aptitudes, trade tests for measuring certain more or less specific aptitudes, trade tests have been developed for measuring technical knowledge of tools, machines, and operations involved on the job. The Survey of Mechanical Insight in an illustration of a brief test designed to measure aptitude for solving the types of mechanical problems involved in jobs requiring the operation, maintenance, repair, or design of different types of mechanical parts of machinery. The directions for giving and scoring the test, like those for typical paper-and-pencil tests of mechanical abilities, are simple.

Many industrial jobs require considerable skill, which of necessity requires training for the job. In such a case, aptitude rather than proficiency tests are needed. The testing program in industry will be of value in vocational selection to the extent that it is based upon sound scientific principles, inaugurated and administered in a co-operative manner with the best human relations. In this connection Bennet and Fear have stated:

Where tests have failed, the reason can frequently be traced to the fact that the installation has bee attempted by inexperienced people who lack the proper background and training for determining what tests to use and how to interpret results once tests have been given. The choice of appropriate tests in any company always depends upon a careful preliminary study of the jobs for which applicants are to be selected, or to which employees are to be upgraded.

Aptitudes For Clerical Work

The clerical field includes a large group of occupations, many of which show little similarity. Many studies have been conducted involving the measurement of clerical aptitudes. The steps up the occupational ladder show the wide range of activities and responsibilities found in clerical positions. Bingham suggests that aptitudes for clerical work are evidenced in part at least by four different kinds of abilities. These are listed as follows:

1. Perceptual ability – the ability to grasp quickly and correctly the numbers and words on paper in their correct order

2. Intellectual ability – the ability to comprehend meanings, to follow directions and make decisions

3. Educational skills – ability to spell correctly, to punctuate, to use a variety of words; to perform the arithmetic fundamentals, and to grow in all these abilities.

4. Dexterity – agility n the use of fingers in filing, typing, and other manipulations required in a business office

The nature of the clerical job will determine the pattern of abilities and traits needed for the optimum of success on the job. Certainly an information clerk would not need the same trait pattern as would a filing clerk. A careful study of the abilities suggested by Bingham would reveal that some of these abilities are very important in connection with certain tasks while other abilities will be more important in the performance of other tasks. Perceptual ability and dexterity can best be measured by special aptitude tests for these traits. The intelligence test provides a good measure of the intellectual quality, while educational skills could best be measured through achievement tests. The Minnesota Vocational Test for Clerical Workers has been found to be useful and valid in the evaluation of aptitudes and abilities for clerical work.

Intelligence and Clerical Ability. It has already been suggested that the term clerical covers a variety of tasks to be performed. A standard mental test should serve as an aptitude test for determining the classification or level of responsibility for which the individual is capable. Pond and Bills have reported results from the use of intelligence tests for selecting workers for different clerical jobs. Their studies revealed that on the easiest clerical jobs the greatest turnover was among those with the highest intelligence test scores, while the greatest turnover among the clerks on the difficult jobs was among the group with the lowest intelligence test scores. These results point to a valuable use of intelligence tests for selecting clerical workers for tasks of varying difficulties and responsibilities.

Aptitudes for Salespersons

Most of the studies relating to the selection of salespersons by means of tests have dealt with either salespersons in department scores or insurance salesmen. The results obtained from studies of these two types of sales work show the same general trend. In the first place, no significant relationship was found between results on such tests as arithmetic, vocabulary, number writing, sentence completion, and the person's success in saleswork. The results from these studies are in harmony with conclusions earlier reached by Anderson, based on a psychiatric study of salespersons in Macy's, that personality rather than intellectual factors was most important in relation to success and job satisfaction.

Personality Traits and Interests. An analysis of the requirements of sales work leads to the conclusion that aggressiveness, extroversion, and emotional stability characterize the successful salesperson. Health and a good sense of humor may be given as further characteristics. Since most personality tests are not sufficiently reliable and valid for use where accurate measures are desired, it becomes very difficult to measure these personality traits. Studies, therefore, do not agree as to the relative importance of the various personality traits measured by personality tests. For the past decade, many of the large life insurance companies have made use of a booklet entitled, "Aptitude Index for Life Insurance Salesmen," for the selection of salesmen. This consists of two parts: Part I, A Prediction Scale, based on personal history items; and Part II, A Test of Personality Characteristics. Research conducted by the Life Insurance Research Bureau has shown this Index to have a high degree of validity for predicting success.

In cases where as individual is being selected for a particular task or position which varies from other jobs of a similar nature, a qualitative analysis of the test results may be helpful. Fleming and Fleming made use of the results of six tests administered to applicants for sales work. The tests were: the Bernreuter Personality Inventory, the Washburne S.A. Inventory, the Otis Self-Administering Test of Mental Ability, the Canfield Test of Sales Knowledge, and the Strong Vocational Interest Blank. The results of these tests were studied

qualitatively in relation to the pattern needed for the different jobs. Estimates from executives of five companies, involving 218 salesmen, indicated that 80 to 90 percent of the analyses were accurate in their evaluations of the men employed.

Aptitudes for the Professions

In the light of very limited opportunities for training in some professional areas, much more effective guidance should be provided. Medical schools, for example, have been accepting less than 25 per cent of those applying for entrance. Likewise, in some states opportunities for training in optometry, forestry, as well as in other professional areas have been considerably limited. The goal should be that of (I) admitting those students into training in those areas who offer the best promise of success, and (2) eliminating those who offer the least promise of success.

High scores on intelligence tests are significantly related to the ability to do the kind of learning involved in the use of language in abstract thinking and in most scholastic activities. Intelligence test scores are only one factor determining success in school subjects although a very important factor. Interests, drives, habits of study, and good personality adjustments have important bearings on school success as measured by school marks. However, there is a minimum of intelligence essential for success at different levels of schoolwork and in different areas of study.

The majority of colleges are making use of psychological tests in the guidance of students. The American Council on Education Psychological Examination is given annually to thousands of beginning students throughout the country. This test provides for a quantitative (Q) score and language (L) score as well as total score. Each of these is broken down into subtests which provides a basis for further diagnosis. In the scholastic fields certain subjects will require superior quantitative scores while in other areas high qualitative scores are essential for success. Mechanical aptitudes and motor skills will be needed in some phases of the educational program. For example, the study by Dreffin and Wrenn, in which comparisons were made between the scores of 69 art students and published norms on the Minnesota Paper Form Board Test, Series MA, shows the art laboratory, commercial, and architectural students to be significantly superior to the average liberal arts freshmen in spatial relations ability. Further evidence of the validity of the spatial relations test as a measure of art aptitude was obtained from the correlation of 0.37 between the test and grades in the art laboratory.

Aptitudes for Engineering. The fact that over 50 per cent of students entering colleges of engineering fail to complete their training, many because of scholastic difficulties, indicates the need for using valid psychological tests in the guidance and selection programs. A high score on an intelligence test, when combined with superior high-school marks and a burning desire (interest) to complete the engineering curriculum, is a good basis for predicting success in this field of study.
Aptitude tests useful in measuring mechanical ability, already referred to, may be useful in determining aptitudes for certain engineering course. The Iowa Placement Tests in Physics Aptitude and Chemistry Aptitude are useful, especially in those cases where the student did not include physics or chemistry in his high-school program of studies. A very complete test of aptitude for science work, especially adapted for senior high school and college, is the Stanford Scientific Aptitude Test. A score of B+ in engineering interest on the Strong Vocational Interest Blank provides evidence of interest in this area which may be conceived of as one element in a profile pattern that should be considered in an evaluation of an individual’s aptitude for engineering.

Medical and Dental Aptitudes. Many more high-school graduates have sought to enter medical and dental schools than there are facilities available for training. This has been a factor leading to the increasingly higher standards of the medical schools and the use of more accurate procedures for selecting students from those seeking admission. The Association of American Medical Colleges has had for about two decades a Committed on Aptitude Tests for Medical Students. The Medical Aptitude Test is given annually on the same date in colleges throughout the United States and Canada. This program is one of the most complete testing programs annually administered. Aptitude for medicine, like most aptitudes, is conditioned by many factors, one of which is the student’s aptitude for learning the type of subject matter measured by the Medical Aptitude Test. Case studies show that a student with an average score on the test may, when other conditions and factors are favorable, attain high scholarship in his medical courses. Interests and drive, health, social adaptability, and good habits of work are factors which cannot be eliminated from a consideration of a student’s aptitude for medicine.

Most of what has been said about the items contributing to aptitude for medicine can be repeated for dentistry. An aptitude test for science, such as the Stanford Scientific Aptitude Test should be valuable in determining aptitude for pre-dental college courses. However, the surgeon and dentist must be craftsmen as well as students of science. Clearness of vision, good tactile discrimination, finger dexterity, and strength of grip are essential qualities. A large percentage of failures in dental schools appear after the student has successfully passed his pre-dental science courses and the first two years of basic physiological and anatomical courses. At this stage the student is introduced into mechanical precisions and manual techniques of dental practice. Manual dexterity tests and certain tests of mechanical ability should be a part of any battery of aptitude tests of mechanical ability should be part of any battery of aptitude tests for dentistry. Also, social adaptability, interests and drives related to this field of study, good health, and desirable study habits will do much to offset the lack of superior aptitude for learning the types of materials involved in pre-dental and dental courses.

Aptitude for Law. Colleges of law, like those of medicine, have been raising their standards. Also, state examinations for admission to the bar, combined with added educational requirements, are demanding special abilities and skills of those choosing this profession. However, many students choose law as a field of study, believing that some elementary training in this field will be valuable to them, even though they do not enter law as a profession. This, no doubt accounts for many students of low ability choosing the study of law, and subsequently the high mortality rate in certain law schools that maintain reasonably high standards.

One of the first carefully developed aptitude tests for law was constructed by Ferson and Stoddard. This examination has been used in a number of law schools to forecast the ability of first-year students to pass their college courses. Statistical studies of results indicate that students scoring below the median point on this test, which can be administered in about sixty minutes, have poor aptitude for the first-year law course and are poor scholastic risks. The Iowa Legal Aptitude Test is a more recent development in this area. This examination includes tests of verbal ability, information and comprehension. Correlations between scores on this test and first-year law achievement indicate that it is a valid test of aptitude for success in law courses. Such tests when combined with other evidences, including Strong's Vocational Interest Blank, should be most valuable to counselors and those concerned with admitting students to schools of law.

Aptitudes for Nursing. Aptitude indicative of the capacity to complete successfully the educational requirements for nursing are somewhat similar to those characteristic of the physician and dentist. However, average intelligence test scores of nurses in training have been found to be much lower than those of students enrolled in premedical courses. Intelligence test scores are only slightly related to success in the practical work of the training course. They are much more closely related to success in the academic courses pursued.

The Potts-Bennett Test is a battery of tests developed as a result of considerable research on the problem of predicting success in nursing. These tests measure educational development in certain abilities and areas, and consist of the following parts: science information, paragraph comprehension, specialized vocabulary, speed of reading, arithmetic process, general information, and arithmetic reasoning. This test, like the Moss Nursing Aptitude Test, has been found to be significantly related to success in schools for nursing. Nursing requires about the same mental ability as teaching and first-grade clerical work. Therefore, for an individual with sufficient scholastic ability to succeed in these endeavors, choice from among such activities should further depend upon interests, personality characteristics, and physical conditions. This is in harmony with a generalization presented over a decade ago by Bingham, as follows:

In general, it may be said that a majority of those who are capable of mastering one profession have a choice among many; and for two reasons. The first is that aptitudes are often not narrowly specialized, so that the chances are equally good in any one of a number of careers. The other reason lies in the nature of the professions themselves; for the kinds of work to be done in any one of them are so varied that there are opportunities for practitioners of widely different talent.

Aptitudes for Teaching. There are some who would hold to the slogan, "Teachers are born, not made." That there may be some truth in this is supported by everyday comments of pupils about their teachers. And, while a high degree of training will not insure a good teacher, there is ample evidence that the quality, as well as amount, of training is related to successful teaching. In an attempt to arrive at the aptitudes involved in teaching, Hellfritzsch made a factor analysis of teacher abilities. His study indicated that four factors were present: (1) general knowledge and intelligence, (2) a high rating on a teacher rating scale, (3) good personal, emotional, and social adjustment, and (4) a favorable attitude toward teaching as a profession. The factors show how difficult it becomes to deal with specifics in a discussion of teaching aptitudes. It is not difficult to determine whether or not an individual has the necessary intellectual abilities for teaching. Past performances in school will give a valid basis for this. Dean Peik of the College of Education, University of Minnesota, suggests that students in the lowest 40 or 50 precentile should be screened, while certain precautions should be observed in connection with student from the upper 10 per cent. In addition to the desired scholastic

ability, an individual should have the interests and values which would lead to job satisfaction as a teacher. Teachers who "feel sorry for themselves as teachers" do not have the requisites for a successful teaching career. The results on some such interest test as the Kuder Preference Record should be helpful in the selection of students to prepare for teaching. A carefully conducted interview should reveal information relative to the student's personality, interests, and values and thus provide a further basis for vocational selection. Perhaps in no field do character, personality, and interests play a more important role in determining vocational fitness than in teaching.

Emotional Intelligence

Major Components of Emotional Intelligence

Goleman suggests that emotional intelligence consists of five major parts: (1) knowing our own emotions, (2) managing our emotions, (3) motivating ourselves, (4) recognizing the emotions of others, and (5) handling relationships. Each of these elements, he contends, plays an important role in shaping the outcomes we experience in life.

Knowing Our Own Emotions:- Emotions are often powerful reactions, so it would seem at first glance that everyone ought to be able to recognize their own feelings. In fact, however, this is not always the case. Some persons are highly aware of their own emotions and their thoughts about them, but others seem to be almost totally oblivious to these. What are the implications of such differences? First, to the extent individuals are not aware of their own feelings, they cannot make intelligent choices. How can they tell whom to date or marry, what job to take, which house or car to buy, or even what to order in a restaurant? Second, because such persons aren't aware of their own emotions, they are often low in expressiveness-they don't show their feelings clearly through facial expressions, body language, or other cues most of use to recognize others' feelings. This can have adverse effects on their interpersonal relationships, because other people find it hard to know how they are feeling or reacting. For these reasons, this first component of emotional intelligence seems to be quite important.

Managing Our Own Emotions:- Have you ever lost your temper or cried when you didn't want to show such reactions? Have you ever done something to cheer yourself up when you felt anxious or depressed? If so, you are already aware of the fact that we often try to manage our emotions-to regulate their nature, intensity, and expression. Doing so is very important both for our own mental health and from the point of view of interacting effectively with others. For instance, consider persons who simply cannot control their temper; are they bound for success and a happy life? No. They will probably be avoided by many people and will not get the jobs, promotions, or lovers they want.

Motivating Ourselves:- Thomas Edison, the famous inventor, once remarked: "Success is two percent inspiration and ninety-eight percent perspiration." Do you agree? While inspiration or creativity is certainly important. I'm inclined to believe that Edison was right. By "perspiration, "however, I mean more than simply hard work: I also include aspects of emotional intelligence, such as being able to motivate oneself to work long and hard on a task, remaining enthusiastic and optimistic about the final outcome, and being able to delay gratification-to put off receiving small rewards now in order to get larger ones later on. Being high in such skills can indeed contribute to success in many different contexts.

Recognizing and Influencing Others Emotions:- Another aspect of emotional intelligence, as described Goleman, is the ability to "read" others accurately-to recognize the mood they are in and what emotional they are experiencing. This skill is valuable in many practical settings. For instance, if you can accurately gauge another person's current mood, you can tell whether it's the right time to ask her or him for a favor. Similarly, persons who are skilled at generating strong emotions in others are often highly successful in such fields as sales and politics: They can get other people to feel what they want them to feel.

Handling Relationships:- Some people seem to have a knack for getting along with others: most people who meet these people like then, and as a result they have many friends and often enjoy high levels of success in their careers. In contrast, others seem to make a mess of virtually all their personal relationships. According to Goleman, such differences are another reflection of differences in emotional intelligence or, as some researchers would phrase it, differences in interpersonal intelligence.

Artificial Intelligence

Artificial Intelligence (AI) generally concerns the mechanization of reasoning. Terminology stems from the notion of intelligence exhibited by man-made systems, usually to be computers. Ambiguity on the interpretation of the word artificial led to the proposal of alternatives such as Synthetic Intelligence or Algorithmic intelligence.

AI forms a vital branch of computer science, dealing with intelligence behavior, learning and adaptation in machines. Research in AI is concerned with producing machines to automate tasks requiring intelligent behavior. Examples include control, planning and scheduling, the ability to answer diagnostic and consumer questions, handwriting, speech, and facial recognition. As such, it has become an engineering discipline, focused on providing solutions to real life problems. AI systems are now in routine use in economics, medicine, engineering and the military, as well as being built into many common home computer software applications, traditional strategy games like computer chess and other video games.

Some of the world's most impressive non-military AI systems currently include:

- Deep Blue – beat the world chess champion
- David Cope's EMI program – composes music in the style of dead composers; fooled humans into thinking they were real
- Mycin – an early expert system that could diagnose a very small set of illnesses in some patients approximately as accurately as humans doctors.
- 20q – A project in AI based on the classics word game of "20 Questions". Has become massively popular since appearing on the internet as 20q.net.
- Speech recognition such as Via Voice now usable by consumers
- Robots in the RoboCup tournament compete annually at a simplified form of soccer

Use of AI in business

Banks use artificial intelligence systems of organize operations, invest in stocks, and manage properties. In August 2001, robots beat humans in a simulated financial trading competition (BBC News, 2001). A medical clinic can use artificial intelligence systems to organize bed schedules, make a staff rotation, and to provide medical information. Many practical applications are dependent on artificial neural networks – networks that patterns their organization in mimicry of a brain's neurons, which have been found to excel in patterns recognition. Financial institutions have long used such systems to detect charges or claims outside of the norm, flagging these for human investigation. Neural networks are also being widely deployed in homeland security, speech and text recognition, medical diagnosis, data mining, and e-mail spam filtering.

Robots have also become common in many industries. They are often given jobs that are considered dangerous to humans. Robots have also proven effective in jobs that are very repetitive, in which humans may find degrading. General Motors uses around 16,000 robots for tasks such as painting, welding, and assembly. Japan is the leader in using robots in the world. In 1995, 700,000 robots were in use; over 500,000 were from Japan.

AI in science fiction

In science fiction AI – almost always strong AI – is commonly portrayed as an upcoming power trying to overthrow human authority as in HAL 9000, Skynet, Colossus and The Matrix or as service humanoids like C-3PD, Data, KITT and KARR, the Bicentennial Man, the Mechas in A.I. or Sonny in I, Robot.

The inevitability of world domination by out-of-control AI, sometimes called "the Singularity", is also argued by some fiction writers like Issac Asimov, Vernor Vinge and Kevin Warwick. In works such as the Japanese manga Ghost in the Shell, the existence of intelligence machines questions the definition of life as organisms rather than a broader category of autonomous entities, establishing a notional concept of systematic intelligence. See list of fictional computers and list of fictional robots and androids.

Basic Questions

Q. What is artificial intelligence?

A. It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.

Q. Yes, but what is intelligence?

A. Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

Q. Isn't there a solid definition of intelligence that doesn't depend on relating it to human intelligence?

A. Not yet. The problem is that we cannot yet characterize in general what kinds of computational procedures we want to call intelligent. We understand some of the mechanisms of intelligence and not others.

Q. Is intelligence a single thing so that one can ask a yes or no question "Is this machine intelligent or not?"

A. No. Intelligence involves mechanisms, and AI research has discovered how to make computers carry out some of them and not others. If doing a task requires only mechanisms that are well understood today, computer programs can give very impressive performances on these tasks. Such programs should be considered "somewhat intelligent".

Q. Isn't AI about simulating human intelligence?

A. Sometimes but not always or even usually. On the one hand, we can learn something about how to make machines solve problems by observing other people or just by observing our own methods. On the other hand, most work in AI involves studying the problems the world presents to intelligence rather than studying people or animals. AI researchers are free to use methods that are not observed in people or that involve much more computing than people can do.

Q. What about IQ? Do computer programs have IQs?

A. No. IQ is based on the rates at which intelligence develops in children. It is the ratio of the age at which a child normally makes a certain score to the child's age. The scale is extended to adults in a suitable way. IQ correlates well with various measures of success or failure in life, but making computers that can score high on IQ tests would be weakly correlated with their usefulness. For example, the ability of a child to repeat back a long sequence of digits correlates well with other intellectual abilities, perhaps because it measures how much information the child can compute with at once. However, "digit span" is trivial for even extremely limited computers.

However, some of the problems on IQ tests are useful challenges for AI.

Q. What about other comparisons between human and computer intelligence?

A. Arthur R. Jensen, a leading researcher in human intelligence, suggests "as a heuristic hypothesis" that all normal human have the same intellectual mechanisms and that differences in intelligence are related to "quantitative biochemical and physiological conditions". I see them as sped, short term memory, and the ability to form accurate and retrievable long term memories.

Whether or not Jensen is right about human intelligence, the situation in AI today is the reverse.
Computer programs have plenty of speed and memory but their abilities correspond to the intellectual mechanisms that program designers understand well enough to put in programs. Some abilities that children normally don't develop till they are teenagers may be in, and some abilities possessed by two years olds are still out. The matter is further complicated by the fact that the cognitive sciences still have not succeeded in determining exactly what the human abilities were. Very likely the organization of the intellectual mechanisms for AI can usefully by different from that in people.

Whenever people do better than computers on some task or computers use a lot of computation to do as well as people, this demonstrates that the program designers lack understanding of the intellectual mechanisms required to do the task efficiently.

Q. When did AI research start?

A. After WWII, a number of people independently started to work on intelligent machines. The English mathematician Alan Turing may have been the first. He gave a lecture on it in 1947. He also may have been the first to decide that AI was best researched by programming computers rather than by building machines. By the late 1950s, there were many researchers on AI, and most of them were basing their work on programming computers.

Q. Does AI aim to put the human mind into the computer?

A. Some researchers say they have that objective, but maybe they are using the phrase metaphorically. The human mind has a lot of peculiarities, and I'm not sure anyone is serious about imitating all of them.

Q. What is the Turing Test?

A. Alan Turing's 1950 article Computing Machinery and Intelligence discussed conditions for considering a machine to be intelligent. He argued that if the machine could successfully pretend to be human to a knowledgeable observer then you certainly should consider it intelligent. This test would satisfy most people but not all philosophers. The observers could interact with the machine and a human by teletype (to avoid requiring that the machine imitate the appearance or voice of the person), and the human would try to persuade the observer that it was human and the machine would try to fool the observer.

The Turing test is a one-sided test. A machine that passes the test should certainly be considered intelligent, but a machine could still be considered intelligent without knowing enough about humans to imitate a human.

Daniel Dennett's book Brainchildren has an excellent discussion of the Turing test and the various partial Turing test that have been implemented, i.e. with restrictions on the observer's knowledge of AI and the subject matter of questioning. It turns out that some people are easily led into believing that a rather dumb program is intelligent.

Q. Does AI aim at human-level intelligence?

A. Yes. The ultimate effort is to make computer programs that can solve problems and achieve goals in the world as well as humans. However, many people involved in particular research areas are much less ambitious.

Q. How far is AI from reaching human-level intelligence? When will it happen?

A. A few people think that human-level intelligence can be achieved by writing large numbers of programs of the kind people are now writing and assembling vast knowledge bases of facts in the languages now used for expressing knowledge.

However, most AI researchers believe that new fundamental ideas are required, and therefore it cannot be predicted when human level intelligence will be achieved.

Q. Are computers the right kind of machine to be made intelligent?

A. Computers can be programmed to simulate any kind of machine.
Many researchers invented non-computer machines, hoping that they would be intelligent in different ways than the computer programs could be. However, they usually simulate their invented machines on a computer and come to doubt that the new machine is worth building. Because many billions of dollars that have been spent in making computers faster and faster, another kind of machine would have to be very fast to perform better than a program on a computer simulating the machine.

Q. Are computers fast enough to be intelligent?

A. Some people think much faster computers are required as well as new ideas. My own opinion is that the computers of 30 years ago were fast enough if only we knew how to program them. Of course, quite apart from the ambitions of AI researchers computers will keep getting faster.

Q. What about parallel machines?

A. Machines with many processors are much faster than single processors can be. Parallelism itself presents no advantages, and parallel machines are somewhat awkward to program. When extreme speed is required, it is necessary to face this awkwardness.

Q. What about making a “child machine” that could improve by reading and by learning from experience?

A. This ideas has been proposed many times, starting in the 1940s. Eventually, it will be made to work. However, AI programs haven’t yet reached the level of being able to learn much of what a child learns from physical experience. Nor do present programs understand language well enough to learn much by reading.

Q. Might an AI system be able to bootstrap itself to higher and higher level intelligence by thinking about AI?

A. I think yes, but we aren’t yet at a level of AI at which this process can begin.

Q. What about chess?

A. Alexander Kronrod, a Russian AI researcher, said “Chess is the Drosophila of AI.” He was making an analogy with geneticists’ use of that fruit fly to study inheritance. Playing chess requires certain intellectual mechanisms and not others. Chess programs now play at grandmaster level, but they do it with limited intellectual mechanisms compared to those used by a human chess player, substituting large amounts of computation for understanding. Once we understand these mechanisms better, we can build human-level chess programs that do far less computation than do present programs.

Unfortunately, the competitive and commercial aspects of making computers play chess have taken precedence over using chess as a scientific domain. It is as if the geneticists after 1910 had organized fruit fly races and concentrated their efforts on breeding fruit flies that could win these races.

Q. What about Go?

A. The Chinese and Japanese game to Go is also a board game in which the players take turns moving. Go exposes the weakness of our present understanding of the intellectual mechanisms involved in human game playing. Go programs are very bad players, in spite of considerable effort (not as much as for chess). The problem seems to be that a position in Go has to be divided mentally into a collection of subpositions which are first analyzed separately followed by an analysis of their interaction. Humans use this in chess also, but chess programs consider the position as a whole. Chess programs compensate for the lack of this intellectual mechanisms by doing thousands or, in the case of Deep Blue, many millions of times as much computation. Sooner or later, AI research will overcome this scandalous weakness.

Q. Don’t some people say that AI is a bad idea?

A. The philosopher John Searle says that the idea of a non-biological machine being intelligent in incoherent. He proposes the Chinese room argument www-formal.stanford.edu/jmc/chinese.html The philosopher Hubert Dreyfus says that AI is impossible. The computer scientist Joseph Weizenbaum says the ideas is obscene, anti-human and immoral. Various people have said that since artificial intelligence hasn’t reached human level by now, it must be impossible. Still other people are disappointed that companies they invested in went bankrupt.

Q. Aren’t computability theory and computational complexity the keys of AI? [Note to the layman and beginners in computer science: These are quite technical branches of mathematical logic and compute science, and the answer to the question has to be somewhat technical].

A. No. These theories are relevant but don’t address the fundamental problems of AI.

In the 1930s mathematical logicians, especially Kurt Godel and Alan Turing, established that there did not exist algorithms that were guaranteed to solve all problems in certain important mathematical domains. Whether a sentence of first order logic is a theorem is one example, and whether a polynomial equations in several variables has integer solutions is another. Humans solve problems in these domains all the time, and this has been offered as an argument (usually with some decorations) that computers are intrinsically incapable of doing what people do. Roger Penrose claims this. However, people can’t guarantee to solve arbitrary problems in these domains either.

In the 1960s computer scientists, especially Steve Cook and Richard Karp developed the theory of NP-complete problem domains. Problems in these domains are solvable, but seem to take time exponential in the size of the problem. Which sentences of propositional calculus are satisfiable is a basic example of an NP-complete problem domain. Humans often solve problems in NP-complete domains in times much shorter than is guaranteed by the general algorithms, but can't solve them quickly in general.

What is important for AI is to have algorithms as capable as people at solving problems. The identification of subdomains for which good algorithms exist is important, but a lot of AI problem solvers are not associated with readily identified subdomains.

The theory of the difficulty of general classes of problems is called computational complexity. So far this theory hasn't interacted with AI as much as might have been hoped. Success in problem solving by humans and by AI programs seems to rely on properties of problems and problem solving methods that the neither the complexity researchers nor the AI community have been able to identify precisely.

Algorithmic complexity theory as developed by Solomonoff, Kolmogorov and Chaitin (independently of one another)is also relevant. It defines the complexity of a symbolic object as the length of the shortest program that will generate it. Proving that a candidate program is the shortest or close to the shortest is an unsolvable problem, but representing objects by short programs that generate them should sometimes be illuminating even when you can't prove that the program is the shortest.